GEOLOGICAL FORMATION OF HYDE PARK,

BY

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THE story of the rocks of the greater part of our whole state is a very complicated one. Only few rocks are now what they were when laid down, — in form, shape, or even in composition.

Volcanic agencies have, in the past, been actively engaged, even more actively than they now are in volcanic regions. In some periods long openings or fissures were made in the earth, and the lava, flowing out of these rents, flooded the whole district for miles in extent. We often find this phenomenon in the rocks of the so-called Boston Basin.

Earthquakes have played an important part in the history of the region. Landslips have occurred and rocks have been rent, forming the joints or parallel cracks that are to be seen almost everywhere.

Then, too, interior heat has caused the rocks to become somewhat plastic. Lateral pressure, produced by contraction of the inner hot nucleus of the globe, and consequent sinking of the cooler and more hardened crust, crushed, folded and tilted the rocks until they formed great serpentine undulations.

Frost, rain and the atmosphere for millions of years have lent their aid to the general work of denudation and deposition, and we have the results of all these agencies before us to study and unravel, if we can.

The "Boston Basin" is a name that has been applied to all of our sedimentary and eruptive rocks of approximately the same geological horizon in Eastern Massachusetts. The oldest of these are the slates of Braintree, containing the famous fossil trilobite, Paradoxides Harlani; the limestones of Nahant and Weymouth, containing the fossil Hyolithes, and many patches of quartzite and schist, that were formerly sandstone and slate, but have been changed by metamorphism. The fossils show these rocks to belong in the lowest division of the Palæozoic Era, the Cambrian Age.

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Next, according to John H. Sears of the Essex Institute, Salem, comes a rock which he has named Essexite. This is an eruptive rock of a dark color, and very porphyritic and schistose in structure. It is composed of the minerals feldspar and augite, with some biotite. This, however, is a local rock, occurring at Marblehead.

The third rock in the series all authorities agree to be diorite, another eruptive composed of basic feldspar and hornblende. The sedimentary rocks, at this early age, were rent in all directions, and the diorite in the form of lava was erupted through them. As an example, A. C. Lane has noted some 500 dikes at Nahant, a town which contains less than a square mile of land, and this mostly covered with soil.

Nature then seemed to pause for awhile, to gather strength for renewed activity, for, after these rocks had become hard, a fourth series, still of igneous origin, was laid down. These were more acidic than the last and of lighter color. The granites, felsites and syenites belong here. Quincy and Dedham granites are typical varieties of this group.

Syenite bears a close resemblance to granite and is like it in composition, except that it contains no quartz, that is, it is composed of orthoclase feldspar only, except microscopic quantities of other minerals.

Felsite is like both in composition, and was the glassy overflow at the time of eruption. Granite never reaches the surface at the time of formation. The overflow during an eruption is called obsidian and varies from the homogeneous glassy mass to the porous, light variety that we call pumice. In time this obsidian devitrifies, or turns to a stony material and forms the felsite so common in Hyde Park.

Again we had a long period of rest, and then the sea and other agencies began their work of denudation. Cliffs of diorite, felsite, granite and quartzite were torn, broken and crushed, and the fragments rolled, with ceaseless energy. Our conglomerates were then formed. We find pebbles of granite, felsite, quartzite and even of slate in the conglomerate. The diorite, which disintegrates much more quickly than the other rocks, was probably reduced to clay and afterwards changed to slate.

Then there are evidences of periods of elevation as well as of subsidence of the earth's crust; for we find our sixth series of rocks composed of flows of melaphyr and porphyrite (both volcanic lavas) *interbedded* with conglomerate and slate.

Another period of rest in which a vast bed of slate was deposited, and then, as Prof. W. O. Crosby says, "The weakened crust below the still unconsolidated sediments could no longer resist the growing horizontal thrust or pressure, and it yielded; and thus inaugurated an important geological revolution. The slate and conglomerate were powerfully compressed in a north and south direction, and thrown into a series of gigantic folds, having a general east-west trend. Although they have suffered enormous erosion, these folds, when not drift covered, are still distinctly traceable." I have quoted this at length because it explains a great deal of our Hyde Park geology. He also says: "The strata was extensively broken and faulted . . . many of the faults and joint fissures being injected by highly liquid rock (diabase)." This general description of the rocks of Eastern Massachusetts has been given in order that the following pages may be better understood.

The geology of Hyde Park presents two natural divisions, viz., the solid rocks, and the superficial deposits, or that part covered with the drift left by the Glacial Age.

In the first division we find rocks belonging to the fourth, fifth and sixth series already mentioned, the granites, felsites, porphyrites, conglomerates and slates, with a number of diabase dikes.

Felsite occupies a prominent place, and we have many beautiful varieties, from nearly pure white to green, pink, red and gray, the difference in color being due to different degrees of oxidation in the iron.

On Pine Garden Rock are found some of the best examples of concretionary structure in felsite. It occupies a small portion of the ridge just north of the German picnic ground. The rock-mass is of a delicate green color, and the concretions are of bright pink. These concretions vary from an almost microscopic size to an inch in diameter, though the average size is about three-eighths of an inch. When examined carefully many will be found to contain a nucleus consisting of a grain of quartz, and to have a radiate structure around the nucleus. This spherulitic structure is one of the stages of devitrification in the glassy obsidians.

The first stages of the process must be studied with a microscope. Under a high objective a thin section of obsidian will be found to be full of minute, imperfect crystals called crystallites. These increase with age and, having an attraction for each other, often segregate around a common centre, forming opaque, stony spots in the rock. It is then called spherulite or spherulitic obsidian. The concretions are often so abundant that the weathered surface has the appearance of conglomerate, as the concretions are slightly harder than the rock-mass, and so do not decompose as rapidly as the latter.

The same rock occurs again in Grew's woods, west of Beaver street, and towards Muddy Pond. This is not as attractive in appearance as that found on Pine Garden Rock, the contrast of ground-mass and spherulites is not as great; the green is a dirty green and the pink a whitish pink, probably due to decomposition.

At the eastern part of the town the felsite assumes the red tints, then as we go toward the west the rock becomes gray and finally merges into granite. At the junction of Arlington and Westminster streets we find an outcrop of the typical red variety. This deeply red rock is very homogeneous and breaks with conchoidal fracture. When weathered it presents a banding of two shades and makes a very pretty rock when polished. It might well be utilized for decorative purposes.

The banding is the result of fluidal motion while in a plastic state, as lava flows from a volcano, and different colors thus become intermingled. These bands are not continuous; they seem to be only enlongated patches. Geikie speaks of this structure in the obsidians of the Lipari islands as "drawn out spherulites."

The darker streaks are harder and withstand decomposition better than the lighter colored ones, for in weathered specimens they stand in ridges on the surface. In fact, in many places, small patches of true jasper are found. At Riverside Square is a fine display of this banding.

Some of the felsite is brecciated, that is, it is full of sub-angular pebbles which are darker than the rock itself. The explanation of this probably is that after the flow of lava had hardened, but before it had become entirely indurated, there was another violent volcanic outburst, breaking the lava into pieces of all shapes and sizes, while the new flow filled all spaces and re-cemented the mass. Wherever we find volcanic breccia like that described above, proximity to the original vent is indicated. This structure is found in the northern part of the town. One typical exposure can be seen near the junction of Metropolitan avenue and Hubbard street.

No volcanic vents have been found in this vicinity, but they must be in a northerly direction, for not a great distance from the locality of brecciated felsite is a mass of tuff, a sandstone made up of volcanic ash, of coarse and fine material, indicating that the original place ot eruption is not far off.

Tuff is an interesting rock, and occurs on the west side of the railroad cutting, just north of the bridge, near River Street station on the New York and New England Railroad.

A large ledge of the gray variety of felsite is found on Hyde Park avenue, bounded by Dell avenue, Lincoln street and Central avenue. This ledge extended also down Hyde Park and Central avenues to West street, until a large portion was blasted away to make room for dwellings.

The same rock was met on Central Park avenue as far south as Clay street. This was much sought for by residents of the town, when blasted by the Water Company. Fine slabs covered with dentrites were procured, under the name of "fern rock," a common misnomer, the mistake of many who regard the impressions as fossil ferns.

From the compact, homogeneous felsites to the coarse-grained crystalline granites, we have a gradual transition, an interesting and unusual feature, not often shown as plainly as it is in this town. The first stage after the felsite is a very fine grained granite, so fine that the constituents can only be told with the aid of the lens. This is called micro-granite or eurite. A small outcrop was found in the woods north of Back street. Other outcrops were in Grew's woods between the felsite and the granite.

One very interesting locality was on the path leading from the Hermit's to Muddy Pond. First was a compact felsite; at the next outcrop was found to be still compact felsite, but with feldspar and quartz crystals developing; just beyond was eurite; and finally granite.

Granite occupies the entire western part of the town, and is probably a continuation of Dedham granite. Some of it is very pretty, having a greenish tinge, due to the presence of epidote. Other outcrops are gray in color, more like the Quincy granite, but nearly free from hornblende.

A small patch of porphyrite is seen on the New York and New England Railroad near the River Street station. This is also an eruptive rock, but of later date, as it is found interbedded with the conglomerate. It looks somewhat like felsite with well-developed crystals of feldspar, but it is composed of a more basic feldspar than the felsite. The eruptive rocks, with the exception of the porphyrite, probably covered the whole township, and from these rocks our conglomerates were made.

A very interesting specimen of stratification of sandstone and conglomerate was seen on River street near Business street — bands of alternate sandstone and conglomerate of about two inches wide. In this same ledge was a large dike of diabase, seven feet broad, and on either side of it the conglomerate was well baked, as no doubt the workmen learned to their sorrow when they tried to blast it.

After the eruption of the granites and felsites there must have been a long period of quiet, for these overflows to have become hardened, before the deposition of the conglomerates began. The sea wore away the ledges, and rounded the angular fragments into pebbles, as it does on our beaches to-day.

Time, with the aid of heat and pressure, changed this shingle-beach to a conglomerate. The conglomerate covered most of the region over the felsites. But after this the great disturbance took place, and the rocks were crushed together into long, corrugated folds, having a general east-west direction.

The rocks on the upper part of the folds, or anticlines, were stretched to their utmost capacity and were easily weathered away, leaving the under rocks exposed. This is why we have these long, narrow areas of alternate felsite and conglomerate.

The southerly line of the conglomerate has the same direction as the Neponset River. It is first seen on River street near the Boston line. It then parallels the railroad track to the river. There are many outcrops in the river-bed. Others occur on Walter street, corner of Pierce; and finally disappear beneath the sand plain beyond Fairmount.

The northerly line begins on Hyde Park avenue, near Arlington street, then crosses the track of the Boston and Providence Railroad; and there is a large outcrop on the corner of West and Austin streets. Ledges are noted all along Austin, Beaver, Childs and River streets, along Dedham street, Glenwood avenue, then in a westerly direction toward the Dedham line. The general strike of the rock was found to be N. 50° E. to N. 70° E. and the dip was to the south-east from 20° to vertical.

In Grew's woods, south of Austin street and south-west of Beaver street, is a well-defined fault, or line showing where the earth's crust has slipped out of its original position. On the side toward Austin street is well-stratified sandstone, with a strike of N. 70° E; dip, S. E. 70° to 80°. This is full of joint planes. On the west side of the fault is felsite of concretionary as well as finely banded structure. The banding is so regular in some places that a casual observer would be apt to call it stratification.

There are no minerals of any importance in Hyde Park,—a few inferior quartz crystals, a small amount of iron ore in the form of hematite, and also pinite, a mineral formed by the decomposition of felsite, comprising almost all.

In preparing this part of the paper, my thanks are due to Prof. W. O. Crosby of the Massachusetts Institute of Technology, for his kindness in allowing me to compare my map with one of his, yet unpublished, and make certain corrections.

Ages passed away before the second division of our geological story, in which we find the superficial deposits, and it is to these that we owe many of our topographical features.

Clarendon Hills, Fairmount and Mount Neponset, as well as the higher portions of Sunnyside, are composed of drift material brought here during the Glacial Age. Fairmount and Clarendon Hills are typical drumlins. Geologists do not all agree on the formation of drumlins, but it is the most generally accepted theory that they were formed under the ice-sheet. Probably some obstruction caused the debris to pause in its onward movement, and then more and more material gradually accumulated, forming it into a rounded hill. Some authorities think drumlins are old moraines worked over by succeeding glaciers, as they are never found, in this vicinity, over forty miles from the southern boundary of the glacial area. Whatever their formation, drumlins are composed of a mixture of clay, some sand and gravel and large and small semi-angular stones or boulders. The boulders usually have been striated, or scratched in transit.

It is a typical feature of drumlins to have surface springs, owing to the substratum of clay or till. This explains why so many cellars on Fairmount suffer from inflowing water.

Mt. Neponset is also a drumlin. Two smaller ones are near Atherton street, and the tops of two still smaller may be seen in the vicinity of Sunnyside street. The lower part of these is covered with a sand plain. Many of the boulders are of conglomerate.

After the glacial period we had a milder climate and the glaciers melted, leaving immense rivers to work over the drift, and the result is our sand plains, clay beds and kames. Kames are long ridges of modified drift, with steep sides similar to those of a railroad embankment. These are formed in the rivers, on the top of the ice-sheet, according to the theory of Warren Upham of the U. S. Geological Survey. They are composed of gravel and well-rounded boulders, which are never striated or scratched, this feature, as well as others, separating them sharply from drumlins. The kame is often stratified, showing water action in sorting the material.

Many of the ponds, swamps and kettle-holes of this town are found in the modified drift. A fine example of a kettle pond may be seen near the rubber works at River Street station. There are two kames on the Readville side of Fairmount, others north of Clarendon Hills station. All the swamps in Grew's woods, as well as in the Clarendon Hills district and the level sand plains all over the town, belong to this period, known as the Champlain Period.

The sluggishness of the Neponset, as well as of other rivers in this vicinity, is due to the fact that the land was elevated during the Ice Age, and the rivers cut deeper beds to reach sea level; then when it subsided the land near their source was left about 200 feet below the level of the sea.

Thus we find laid down in geological succession the granites and felsites, both eruptive rocks, the latter being merely the overflow of the former; overlying these, are the conglomerates and slates, interbedded, in the eastern part of the town, with porphyrite; after these were laid down the great disturbance crushed the rocks into long folds, their tops being eroded, leaving the long, narrow areas of alternate felsite and conglomerate. Lastly, over the whole, we find drift material — drumlins caused by the ice itself, and kames, sand plains and swamps, due to subsequent water action.